(Archives)

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elec ing machines

contents

cover

The computer ORACLE of the Oak Ridge National Laboratory is shown on the cover. The operator at the console is a Georgia Tech graduate, R. J. Klein, B.S. in E.E., 1950.

the research engineer

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authors

I. E. Perlin, Professor of Mathematics and Research Associate, holds the B.S., 1932, and M.S., 1933, from Northwestern and the Ph.D., 1935, from Chicago. He taught at Northwestern and Illinois Institute of Technology before serving in the U. S. Navy, 1942-45. Since 1945 he has been at Georgia Tech, where he now is responsible for developing the computer center.

John H. Tolan, Research Physicist, holds the B.S. in Physics from Georgia Tech, 1950, and has taken graduate studies at Vanderbilt. He also is Consulting Physicist in the Department of Radiology, Emory University School of Medicine and Consultant to the Oak Ridge Institute of Nuclear Studies. He held an Atomic Energy Commission fellowship, 1950-51.

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Electronic Computing Machines

I. E. PERLIN, Professor of Mathematics and Research Associate

THE ADVENT of electronic computing machinery has heralded the birth of the age of automation, with its two facets, the automatic control of machinery and the rapid processing of data. This period in human history gives promise of the greatest achievements in every field of technical endeavor. In the last decade we have witnessed tremendous advances in the application of automation to uses in science, engineering, business and industry.

In science, research problems which had been impossible or impractical without electronic computers now are undertaken routinely and successfully. Problems which formerly required many years of hand computation now are resolved in a few months by the use of high speed electronic computers, such as the ORACLE shown on the cover.

In engineering, it is possible with computing machinery to test designs under near-actual conditions in a matter of months, whereas without computing machinery the same tests would require many years and fantastic expense.

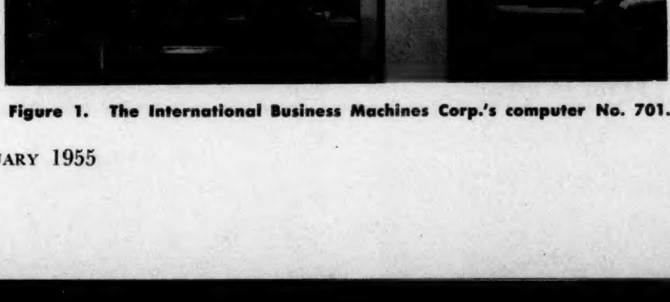


Figure 1. The International Business Machines Corp.'s computer No. 701.

In business, the use of high-speed computing machinery results in considerable savings in cost accounting, billing, inventory control and business management. The business executive has access to the figures he needs for successful management at the time when decisions must be made. The company also is able, because of computers, to give its customers better service at lower cost.

In industry, the use of computing machinery results in automatic control, the elimination of waste, improved marketing and distribution and better products at lower cost.

Even in military organizations, computers perform many jobs, eliminating armed forces' paper work and keeping inventory of the vast means for waging war.[1]

Historical Highlights

The first so-called automatic factory was a flour mill built by Oliver Evans in 1783. Its "automation" was strictly one of conveying equipment. But, along with Eli Whitney's development of piece-part standardization and interchangeability for manufacturing muskets in 1789, and Henry Ford's adaptation, more than a century later, of packing house production-line techniques, Oliver Evans' flour mill constituted one of the forerunners of today's automation.

The most important advance in the field of digital computers has been the development of machines capable of carrying out, automatically, lengthy sequences of arithmetical operations. The machines are designed so that the computing sequence can be changed from problem to problem.

The concept of such a machine is not new. The original idea for a digital differential-equation solver, complete with means to print the answers, seems to have occurred to Charles Babbage, an Englishman, in 1812. The British government supported the construction of his "analytical engine" until 1833 when work was suspended, and they finally abandoned the project in 1842. Babbage, who was Lucasian Professor of Mathematics at Cambridge University, 1828-39, was about 100 years ahead of his time.

The first large automatic digital machine actually built was the IBM Automatic Sequence-Controlled Calculator developed by Prof. Howard Aiken and the International Business Machines Corp. and completed at the Computation Laboratory at Harvard University

Figure 2. The computer UNIVAC of Remington Rand, Inc. is controlled from this panel.

Figure 3. The computer WHIRLWIND of the Massachusetts Institute of Technology.

in 1944. Although differing from Babbage's analytical engine in construction, it was somewhat similar in principle.

The second large automatic digital machine was the Bell Telephone Laboratories' Relay Calculator, the third was another machine built by Professor Aiken, and the fourth was the ENIAC, developed by Dr. L. Lavan Mauchly and Prof. W. J. Eckert for the Ballistics Research Laboratory at Aberdeen Proving Ground. The latter, the first to make use of electronic circuits, ushered in the era of high-speed computers.

Two of the best known computers available commercially are the International Business Machines Corp.'s Model 701, shown in Figure 1, and Remington Rand, Inc.'s UNIVAC, shown in Figure 2. These and other manufacturers often participate in the construction of the giant research computers, such as the Massachusetts Institute of Technology's WHIRLWIND, shown in Figure 3. The principal components of such machines are constructed on assembly lines, as seen in Figure 4.

Classes of Computers

In discussing computers, it is convenient to distinguish two classes of equipment for carrying out numerical computations, namely machines which work by mechanical means and machines which work by electrical means. The former, the mechanical or analog machines, translate numbers into physical quantities, of which the numbers are the measures. For example, they may translate numbers into lengths, voltages, angles, etc. The machines combine these physical quantities in various ways to perform the operations of addition, multiplication, etc. Finally, by measuring some physical quantity, the machines obtain the required result. For example, a product, xy, may be evaluated by adjusting the length of a rod to have the value x inches, then rotating the rod through an angle θ of y radians, and finally measuring the arc S in inches, as shown in Figure 5.

Analog-type computers are useful in solving problems which can be reduced to an electrical analog. Examples of such equipment are the slide rule, the planimeter, the harmonic analyzer, the differential analyzer and the A-C Network Analyzer, which the Georgia Tech Engineering Experiment Station has employed so successfully for the past seven years in the study of electrical power systems.

Digital computers, on the other hand, operate with numbers in their digital form, usually by counting discrete objects or discrete electrical pulses. Examples of digital machines include the familiar desk calculators, as well as the giant "electronic brains" capable of performing prodigious feats. Such scientific and data processing machines will be found in the Computer Center of the Georgia Tech Engineering Experiment Station, as described on page 11 of this issue.

The two classes of computers have some advantages and disadvantages. An analog machine is restricted to a rather narrow range of applications. Furthermore, it is limited by the mechanical and electrical accuracy of its components and by the attainable accuracy of physical measurement of the result. On the other hand, it is possible to design analog machines to deal with continuously varying, as well as discrete, data.

A digital machine can handle numbers expressed in digital form only to a finite number of significant figures; it cannot deal with continuously varying data or continuous processes. On the other hand, such a machine can be designed to work without difficulty to any prescribed degree of accuracy. It is not necessary for any component to be constructed or any measurement to be made to unreasonable limits of accuracy. Furthermore, digital machines can be used for general purpose applications.

Basic Components

The four basic parts of a digital computer are the input-output unit, the storage or memory device, the arithmetic unit and the control unit. These are shown in the block diagram Figure 6.

The numbers and the numerical code for the computing steps comprise what is known as the program. The beginning and end of the computing problem both come in the input-output unit, for it is there that the program is read into the computer, and the answers are read out, or printed in usable form. The steps in between are performed by the storage or memory device, which holds pertinent information in a large number of storage registers; the control unit, which translates the operation codes and which sequences the computing steps; and the arithmetic unit, which performs arithmetic operations.

Types of input devices, through which the machine receives data, include the following:

1. Switches, which can be set to correspond to components of the problem.
2. Modified electric typewriters, which are coupled to the computer and which operate at two to 10 characters per second.
3. Paper tape devices, mechanically read, such as teletypes or Flexowriters, which operate at about five to 20 characters per second.
4. Paper tapes, photo-electrically read, which operate at rates up to 1,000 characters per second.
5. Magnetic tapes and wires, which may operate at rates up to 10,000 characters per second.

Output devices may or may not be similar to input devices. Types of output devices include the following:

1. Modified typewriters.
2. Teletype punches, which punch holes in teletype tape.
3. Magnetic tapes, which are usually used for auxiliary storage but which sometimes may be used as output media.
4. High-speed printers.
5. Cathode ray tubes, which display photographically a record of the results.

Memory devices that are used in computers include the following:

1. A Williams tube, in which a binary digit is stored as a charged spot on an insulator inside a cathode ray tube.
2. A mercury delay line, in which a binary digit is stored as a compression wave in a pool of mercury.
3. An acoustic delay line, in which sound waves, representing digits, travel through a substance.
4. A magnetic, rotating drum, in which a digit is stored as a magnetized spot on the surface.

5. Magnetic tape, in which a digit also is stored as a magnetized spot on a tape.

6. A magnetic core, in which a binary digit is stored as the sense of the residual magnetic flux in a toroidal magnetic core.

Engineering Applications

High-speed electronic computers have been used since about 1945 to solve scientific and engineering problems of an infinite variety and an almost incredible complexity. In the last year or two, increasing numbers of businesses have begun to employ high-speed computers. In science and engineering, computers are utilized in atomic energy studies, guided missile investigations, weather analyses and forecasting, aerodynamical studies, structural analyses, heat transfer studies and other investigations in the fields of mathematics, physics, chemistry and statistics.

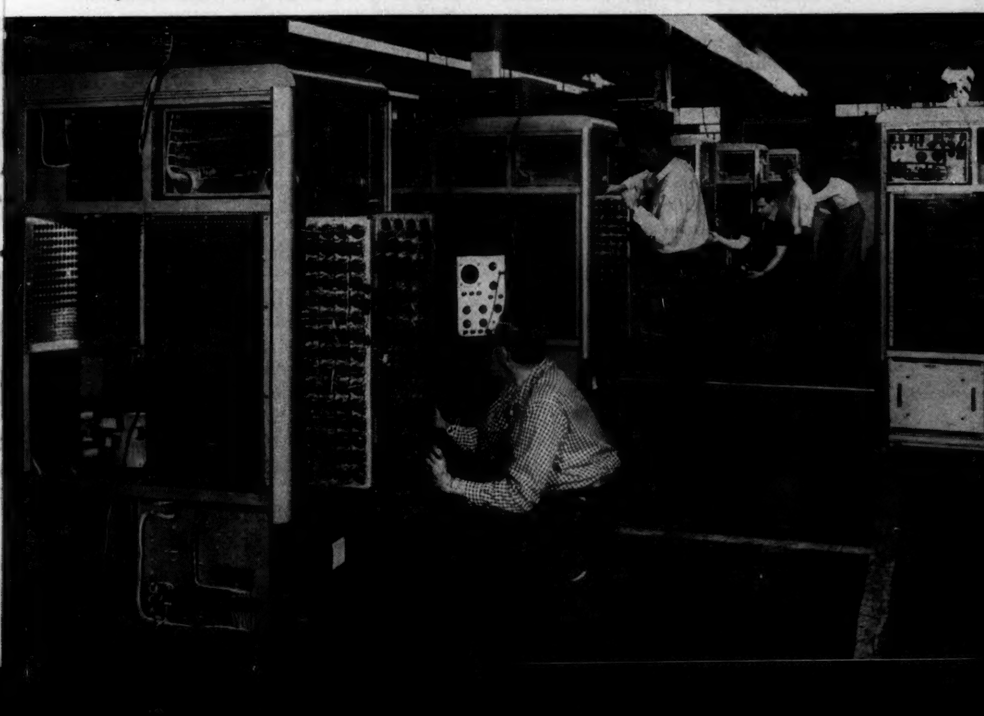
One interesting problem is the steady state alternating network analysis, in which the circuit characteristics and the alternating voltages applied in each loop of the network are known. It is required to determine the current flow and the power distribution. By solving this problem for various sets of circuit characteristics, the engineer can determine the circuit characteristics which yield a satisfactory power distribution. This problem requires the solution of n equations in n unknowns in the general case. In the past, engineers have found it simple to construct the network on a small scale, with variable elements, and observe its behavior rather than solve the equations. However, this problem has been set up for solution on digital computers. The resultant savings in money and time have been substantial.

Functions in Business

Computer applications which are common to many businesses and other organizations include the following:

1. Payroll processing. Permanently maintained on magnetic tape are such data as each employee's name, address, clock number, rate, number of dependents, social security number, age, insurance premiums and other information pertinent to the payroll. The single periodic item of information which trig-

Figure 4. Here is a portion of the assembly and test line for the general purpose computer Model CRC 102-D at the Electronics Division, the National Cash Register Co.



gers the process of computation is the number of hours each employee works. With that raw data added, the computer calculates the gross pay, makes reductions, tabulates the employee's and employer's social security contributions, compares the amount deducted to date for social security, stops deducting when this reaches the specified limit and, finally, reads onto a final payroll tape all the data to be printed on the payroll check.

2. Cost accounting. Direct labor charges can be calculated and printed for each day period as a by-product of the payroll job. The data are used as part of the cost-accounting job. Files on mailing, advertising, purchase orders and sales can be maintained. From these files sales-analysis information can be compiled readily.

3. Budgeting. The preparation of budgets involves the use of multiple correlation procedures and statistical calculations which are similar to engineering calculations.

4. Production control. The scheduling of parts and the control of production processes can be handled efficiently.

Examples of Data-Processing

A wide range of organizations today uses electronic computers in the study and analysis of information. Some of these companies and agencies, and the uses to which they put computers, are as follows:

1. Insurance companies use electronic computers to do most of the accounting work involved in day-to-day operations, including life premium billing. In addition, insurance companies use such machines in calculating actuarial tables, preparing reports for management, maintaining policy files, etc.

2. Department stores and mail-order houses utilize electronic computers in keeping accurate, up-to-the-minute inventories. Special equipment is now being designed to perform this job even more efficiently, as well as to provide information pertaining to sales.

3. Traffic control systems utilize computers as efficient central data-processors and coordinators, to aid in the control of air or vehicular traffic.

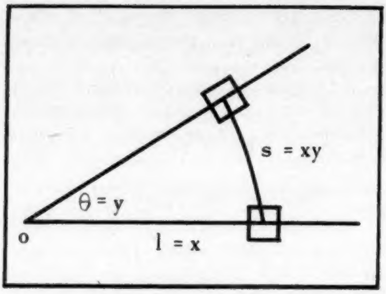


Figure 5. This sketch shows an example of a computation which can be performed by an analog device. A product, xy, may be evaluated by adjusting the rod to correspond to the value x inches, then rotating the rod through an angle θ of y radians, and measuring the arc S in inches.

4. Airlines and railroads use computers in the automatic handling of reservations, efficient scheduling of planes, trains and crews, and in keeping inventories of railroad cars for cross-billing purposes.

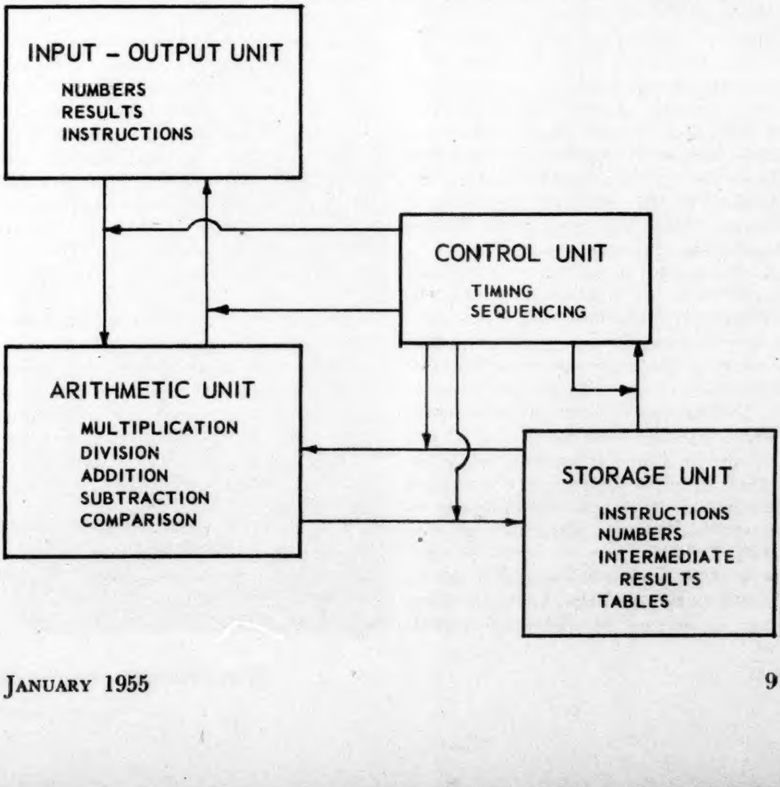
5. Direct-mail organizations, such as large weekly magazines and daily newspapers, newsletter publishers and direct-mail advertisers, utilize computers for automatic mailing. The mailing file is kept up-to-date with additions, deletions, changes in address, etc., easily made on magnetic tapes with no waste effort or material and with economy of storage space.

6. Government agencies utilize high-speed computers in many ways; in fact, the Bureau of Census, the Bureau of Internal Revenue and the Social Security Administration pioneered in this field. It may be interesting to note one job recently completed by the Bureau of Ships, Department of the Navy. When the new Uniformed Services Survivors' Benefit Law was enacted by the 83rd Congress, it became necessary immediately to prepare actuarial tables for this program. Using conventional methods by desk calculation would have required

an estimated 40,000 man-hours, or 20 man-years, at a cost of $200,000. Actually the Bureau, using its computer, took only 1,443 man-hours, or 8.3 man-months, at a cost of only $15,000.

7. The mass media of communications, television, radio and newspapers, use computers to tabulate and predict election results. Millions of persons first became acquainted with computers on election night, November 1952, when the Columbia Broadcasting System first used UNIVAC in this manner. On the basis of scant, early returns — information which was fed into the computer by its human operators — it forecast at 8:30 p.m. that Eisenhower would win. The prediction was within four electoral votes and about 1 million popular votes of the final outcome. Again, in the election of November 1954, the same network used the same electronic brain, with, however, somewhat less success; due to what was reported to be human error, the wrong figures were broadcast. In Detroit, in the same election *The Times* used Wayne University's computer UDEC, built by the Burroughs Corp. At 11:15 p.m., with results available from only approximately 150 of the state's more than 4,000 precincts, UDEC accurately predicted the outcome of the races for governor and senator. Moreover, the prediction on the total vote in each race was virtually 100 per cent accurate. Journalists expect to make even greater use of computers in predicting and tabulating election results in the future. The first effort also was made in 1954 to combine voting machines and computers, so that official results might be available minutes after the polls are

Figure 6. This diagram shows the arrangement of the four basic circuits of a digital computer. The steps performed by each unit are implied in the titles, with examples shown under each title. The paths traveled by the data are shown by arrows.



closed. Thus, in the future, computers may become, literally, instruments of democracy.

Examples of Automatic Control

Electronic computing machinery makes possible not only the rapid processing of data, but also automation, including automatic production, automatic handling and automatic control of other machinery. Four examples will suffice:

1. The sprawling, $1.3 billion atomic energy plant on the Savannah River is as nearly robot-run as possible, the chief engineer of the company which built it said recently. The tremendous potential energy within the atom must be released so gradually, he said, that human operation would scarcely be sensitive enough to exercise control. Consequently, the operating company utilizes automation to monitor and control every phase of production, making the plant not only automatic, but to a large degree semi-perpetual, too.

2. A large motor car company uses automation in one engine manufacturing plant to link 42 separate transfer machines into what might be called one gigantic transfer machine. Automatic devices correctly position the work-piece, a 180-pound cylinder block casting, for each successive machining operation. From the time the cylinder block is deposited at the entrance end until it emerges, after 555 cutting and drilling operations, it is never touched by a man. Automatically, it has traveled through more than an acre of machinery, its quality has been inspected thoroughly, often by automatic gauging equipment, and it is ready for assembly. The machine produces 100 pieces per hour. It is divided into five sections, any one of which can be shut down for a tool change or minor adjustment while the others keep on producing. If necessary, production in the closed section can be caught up during a lunch hour or extra shift.

3. A jet engine manufacturer utilizes a new boring machine for stator housings to operate 55 high-speed carbide tools. Automatically, and at a cost of 90 cents, it performs an operation which used to take many man-hours and cost $1,200. It also condenses, into 20 square feet, a plant which used to occupy 20 acres. Finally, it replaces $52 million worth of machinery with automatic equipment costing only $250,000.

4. A midwestern railroad has installed in its switching yards an electronic freight-car switcher and coupler which is expected to save millions of dollars in rolling-equipment maintenance and freight-damage claims. The electronic yardmaster measures the speed of a freight car, brakes its velocity and eases the car onto a selected track, where it gently bumps a coupling. Railroaders call it "push-button railroading." Computers could be adapted to control other types of traffic, as well.

Future of Computers

The age of automation is here, and certain trends are clearly evident. Many kinds of scientific and engineering laboratories cannot keep pace without research computers. Certain kinds of businesses and factories cannot compete without automatic machinery. Research on computers themselves constantly is improving them; the high-speed devices of the future will be much smaller due to the use of transistors. With the development of printed circuits and better materials, the cost of such machinery will be reduced considerably. The development of automatic programming — in which the computer prepares its own program — will relieve the human operating staffs of many weeks of program preparation now required for each hour of computation. The automatic factory and the automatic office are not visions dimly seen in the distant future; they are realities today.

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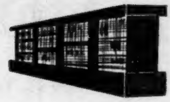
computer chronology



In the growth and expansion of the Engineering Experiment Station, the most significant development forthcoming in 1955 is the establishment of a Computer Center, the first at any Southern college. To keep the readers of The Research Engineer *informed about this program, we inaugurate herewith a new department, Computer Chronology, which shall be a calender of newsworthy steps toward the completion of the Computer Center.*

Mr. Ben R. Gordon, executive vice president, Rich's, Inc., whose Rich Foundation is contributing generously to the Computer Center, operated the power shovel at the groundbreaking ceremony on December 16.

March 29, 1954. The School of Mathematics and the Engineering Evening School began the first of a series of courses in the operation of electronic, high-speed computing machines.

April 14. The Board of Regents of the University System of Georgia approved plans for the Rich Electronic Computer Center at the Georgia Tech Engineering Experiment Station. The regents also accepted grants of $85,000 each from the Rich Foundation of Atlanta and the Georgia Tech Research Institute; authorized Atlanta Architect A. Thomas Bradbury to draw plans and specifications for a Computer Center wing of the Station's Research Building; and requested the University System Building Authority to allocate $170,000 for construction of the wing.

July 14. The Board of Regents approved preliminary plans for the Computer Center wing, and the Building Authority authorized $170,000 for its construction.

November 18. The contract for construction was awarded to Concrete Builders, Inc., of Atlanta, whose bid of $132,867 was the lowest of 16. The approximately $40,000 remaining in Building Authority funds will be devoted to furniture and other equipment.

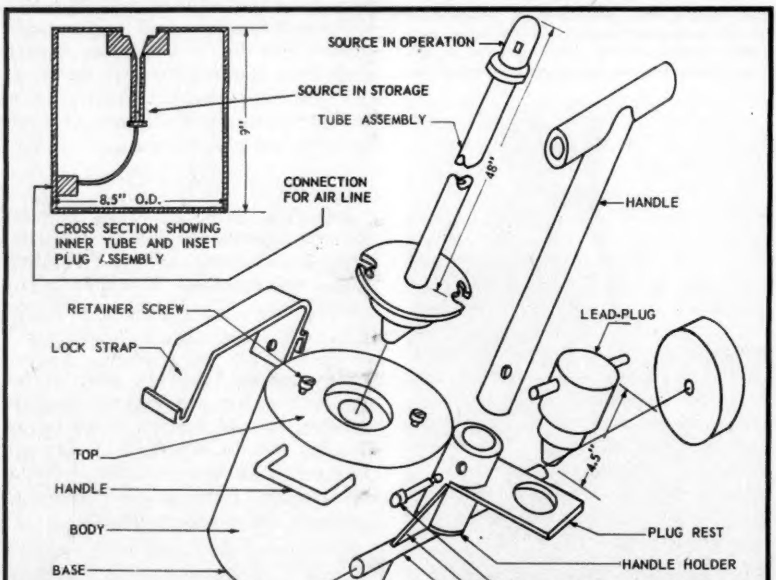
December 16. Ground was broken, at the corner of Campus Drive and Third Street, for the Computer Center wing, which will be the third major addition to the Research Building since its erection in 1939.

A Device for Calibrating

JOHN H. TOLAN, Research Physicist

ON JULY 16, 1945 on the desert near Alamogordo, New Mexico, and again on August 6, 1945 at Hiroshima, a new dimension – radiation – was added to modern warfare. Much has been said and written about the terrible destruction wrought at Hiroshima and at Nagasaki three days later by the blast and heat from the first atomic weapons. But basically man has learned to live, albeit uncomfortably, with the effects of blast and heat; man was inexperienced not in the effects but in their magnitude. Conversely, man knew little about radiation, and its effects; and even now man has not solved many of the new problems presented. As the atomic bomb was used in Japan, the intent was to achieve a maximum blast effect, with the result that the radiation effect was minimized; present civil defense concepts are based on these facts. However, any realistic

Figure 1. The parts of the unit are assembled as shown in this sketch. Here the tube assembly is about to be placed into the operating position. Note the body cross section.



Radiological Instruments

planning for defense against these weapons must not exclude a consideration of the radiation, especially since recent weapons tests with the thermonuclear or "hydrogen" bomb have produced an increasing radiation problem.[1, 2, 3]

Some Basic Considerations

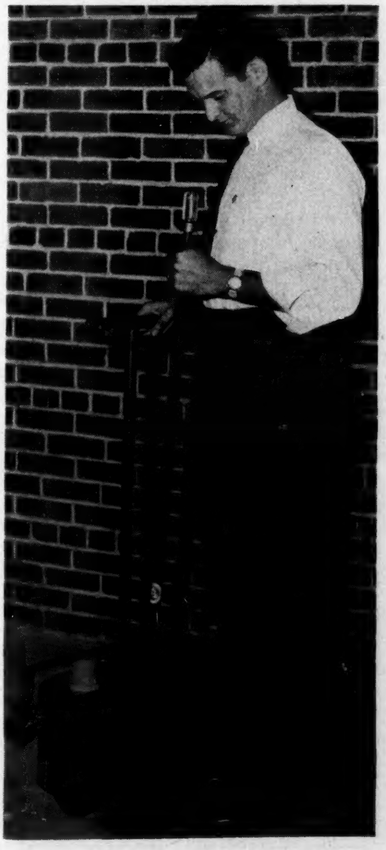
What types of radiation are present in an atomic explosion, what are their relative magnitudes, and to what extent do they damage the biological mechanism called man? At the present time only qualitative answers can be supplied for most of these questions. For example, it is known that corpuscular radiation in the form of neutrons, alpha and beta particles and electromagnetic radiation in the form of gamma rays are involved in the atomic explosion. Much needs to be learned, however, of their distribution, relative intensities and biologic effect. When the radioactive material is outside the body, the principal hazard is from beta particles and gamma rays; when the radioactive material is contained within the body, the principal hazard is from alpha particles.

If a civil defense organization is to protect a population against radiation, it must have some method of detecting the presence, and measuring the intensity, of the radiation. Instruments have been devised which accomplish both objectives. Unfortunately, it has not been possible to devise a single instrument which can cover the range of intensities encountered, discriminate as to type of radiation and still be rugged enough for field use and inexpensive enough to be practical for large scale purchase.

Instruments Now Available

Lacking a single instrument which would satisfy the overall requirements, the Federal Civil Defense Administration has sponsored contracts for the development of three instruments for the detection of sources of radiation external to the body. The three instruments all detect gamma radiation, and cover an intensity range from the normal background level to that which would be fatal to man in an exposure period

Figure 2. Here the unit is shown in the transport or storage position. John R. Fields, Technical Assistant, removes the tube assembly, the first step in disassembling the unit before its operation.



of an hour or more. In addition, two of them are capable of selectively detecting and measuring the intensity of the beta radiation. These are the instruments which will be most numerous in the civil defense program and which will be subjected to the greatest abuse in field operations. Since alpha radiation constitutes a different type of hazard, its detection requires a different group of instruments; these instruments will not be discussed in this paper.

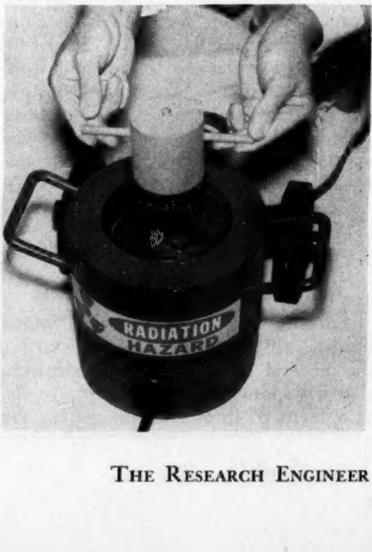
Why Calibrate?

Sensitive electronic instruments, no matter how well designed and constructed, are subject to failure of components and/or changes in characteristics of components, especially when subjected to rough usage. As a consequence, all instruments used in a civil defense program must be maintained and calibrated periodically to insure that they will function as needed in an emergency. The nuclear measurements laboratory of the Engineering Experiment Station, Georgia Institute of Technology, is conducting a study of maintenance problems of radiological instruments for the Civil Defense Division, Georgia Department of Defense. This program is directed toward the establishment of standards and facilities for large numbers of radiological instruments. The laboratory also has studied the problem of calibration of these instruments and has designed and constructed a unit with which a person can economically and effectively calibrate large numbers of instruments.

If a single type of radiation should be selected as that most generally encountered in atomic explosions, it would be gamma radiation. Of the large numbers of gamma-emitting radioisotopes available, a selection based on considerations of availability, useful life, cost and intensity eliminates all but radiocobalt. To facilitate the procurement of such sources of radiation by states, the Federal Civil Defense Administration has made arrangements with the Atomic Energy Commission to supply, on indefinite loan, at no cost except for shipment, sources suitable for calibration. It is for this type of source that the device described below was designed.

Many factors must be considered in the design of a calibration device, but the problem simply stated is one of providing a remotely operated source which is of sufficient intensity to cover the range required and which is stored in a shielding container of reasonable dimensions. The basic limitation considered here was that of weight. It was concluded that the unit would not be sufficiently portable if it weighed more than 200 pounds. With this figure as a limit, it was then only necessary to calculate the dimensions of a right circular cylinder (the simplest form to fabricate) of lead having a height equal to the diameter. With the radius serving as the minimum shielding thickness to prevent an unsafe level of radiation from penetrating the shield, it was possible to calculate the maximum source intensity that could be contained. This source intensity is three curies of radiocobalt which has a gamma radiation equivalent of about

Figure 3. After removing the tube assembly, handle and lock strap, and connecting the air hose, the operator carefully lifts the lead plug and brings it back to the plug rest. The tube assembly next is placed into position and locked, and the unit is now ready for safe operation.



five grams of radium. It is sufficient to cover the range required, so that the only other design considerations were in modification of the basic cylinder to provide maximum flexibility.

The assembly of the parts of the device and their relationships to one another are shown in Figure 1. The source proper is a right circular cylinder of irradiated cobalt metal one-eighth inch in diameter and one-fourth inch long. This source is encapsulated in a sealed container one-fourth inch in diameter and nine-sixteenths inch long which prevents the normal flaking of the cobalt metal from contaminating the mechanism. The encapsulated source rests at the bottom of a recessed opening in the lead cylinder, shown in cross section at the upper left of Figure 1, until air pressure is supplied to lift the source through the tube to the exposed position at the top of the tube. A slight air leak around the source capsule and out through a small hole in the lucite cap is required to hold the source in position. The source remains in this position until the air pressure is released, and the source falls back to its rest position.

The instruments to be calibrated are placed at predetermined distances from the source and their scales read through binoculars. The scale reading is compared to the measured value at the location of the instrument. Uniform deviations of scale readings from one scale range to another can be rectified by adjustment of each instrument. Nonuniform deviations can be compensated for only by the preparation of a conversion chart for each scale range.

Steps in Operation

Ordinarily the calibration unit, assembled as shown in Figure 2, is stored in a locked room to which only authorized persons have access. When it is used, it is wheeled like a lawnmower to a nearby paved lot and stationed in a marked position. Beginning with the assembly as shown in Figure 2, the following six steps are necessary before the unit is ready to function:

1. The tube assembly is removed from its holder clamps on the handle and laid aside.
2. The handle also is removed and laid aside.
3. The air line is connected to the fitting on the side of the container.
4. The lock strap is removed, freeing the lead plug.
5. The lead plug is carefully lifted up, brought straight back and placed in the plug rest, as shown in Figure 3. As the source is now exposed through the one-quarter inch hole, the operator must exercise care to prevent exposure.
6. The tube mentioned in step 1 above is grasped at the upper end and placed into position and turned to lock it securely. The tube is self-aligning so that the source capsule will not become lodged in transit.

Only the last step requires exposure to radiation, but experience in manipulation will keep this exposure at a minimum.

The calibration device is now ready for operation, and all further manipulations are controlled remotely by air pressure. When the calibrations have been completed, release of the air pressure permits the radiocobalt source to drop back into the shielded container, and the reverse order of operations returns the unit to its storage position.

Ordinarily, this calibration unit

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5	Massachusetts Institute of Technology
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11, 13, 14	L. C. Prowse*

*Indicates Photographic & Reproduction Services, Engineering Experiment Station.

would be used by a civil defense group only once or twice a month. With that frequency of operation the average exposure to personnel would be small, although routine personnel monitoring procedures should be followed and records kept of exposures.

Conclusion

The objective of this development was to provide a calibration device of maximum flexibility, having a source capacity large enough to cover the range of intensities required, without reducing portability and at a minimum of cost. Calibration units can be constructed at costs of many thousands of dollars to satisfy various requirements. As is the case with other civil defense agencies, the Civil Defense Division, Georgia Department of Defense, did not have funds available for the construction of a complex and expensive mechanism. Consequently, the instrument described above was developed to satisfy the need for an efficient, economical device for calibrating radiological instruments.

Increasing use of radioactive materials by industry creates new research and development problems. Experience gained in the applications of these materials will assist the Engineering Experiment Station in meeting this challenge.

ACKNOWLEDGEMENT

The author is indebted to Research Engineer Thomas A. Elliott, Head, Mechanical Design Section, for assistance in the design and construction of the radiological instrument calibration unit.

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index available

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Georgia Tech Library Named AEC Station

The Georgia Tech Library has been designated by the Atomic Energy Commission as an official AEC industrial information depository.

Mrs. J. Henley Crosland, director of libraries, said that the new designation means that Georgia Tech will have available the non-restricted reports issued by the AEC and its contractors. Only three other such centers previously had been named. They are in New York, Chicago and California.

"Southern industry should find this a valuable new resource for atomic energy information," Mrs. Crosland said.

The library will be furnished almost all AEC reports; the few exceptions may be requested from the AEC on loan, as needed. Researchers, businessmen or students using the new facility at Georgia Tech may consult the library's copy of any report or may obtain a copy on photostat.

Master drawings of AEC-developed equipment will be included, as well as publications. The collection is expected to include engineering drawings of all research reactors.

the president's page

EVERY SUFFERER from the drought of 1954 should appreciate what a government official meant when he recently said that the problem of adequate water supplies is the most vital and complicated challenge facing the nation today.

Water, the indispensable fluid, was critically scarce last year in many sections of the country, especially Georgia, Alabama and South Carolina. The rivers of Georgia reached their lowest ebb since the great drought of 1925. Some of our utilities and industries had to curtail operations. A college in Alabama was forced to suspend classes when the community's water supply ran out. In Georgia alone, crop losses amounted to more than $100 million. The farmer must have five years of high production to make up his losses.

Yet, if you look at a topographic map of Georgia, you realize that the state is rich in water resources. The U. S. Geological Survey estimates that half of the state's tragic crop loss of $100 million occurred within 500 vertical feet of South Georgia's plentiful artesian water beds. An investment of a fraction of that sum in artesian wells, adequate farm ponds and irrigation systems might have prevented most of that ruin.

Fortunately, many industrialists and state and federal officials recognize the problem. During his campaign, Governor Marvin Griffin was an exponent of water-resource development, and after his nomination he said: "I don't know of any better way to guarantee the future prosperity of Georgia than to constantly develop our water resources."

Georgia Tech stands ready to apply to the water-resource problem considerable research experience along these lines, particularly in the bioengineering laboratory of the Engineering Experiment Station and the hydraulics laboratory of the School of Civil Engineering.

Georgia municipalities and industries rely heavily on the bioengineering laboratory for advice and consultation on the problems of pure water and the prevention of pollution from municipal and industrial wastes.

At the same time, other Georgia Tech investigators are studying the problems of the quantity of water. The School of Civil Engineering boasts the most outstanding hydraulics laboratory in the South. Its director is the consultant on hydraulics research to the Geological Survey, and that government agency's comprehensive national program of open-channel research is headquartered at Georgia Tech.

Georgia Tech is eminently qualified by experience, staff and accomplishments to serve as the keystone of a statewide, coordinated effort by government and industry to solve Georgia's complex problems of water. Plans are now being made to establish a State Water Resources Laboratory, in which these and other studies would be coordinated and expanded.

Water is Georgia's greatest natural resource, indispensable to industry, agriculture, recreation, health, even life itself. Georgia must nurture and protect its water, much as it has conserved its soil and its forests. If enough Georgians put enough effort into this program, our descendants might forevermore refer to the drought of '54 as "the last great drought to cause widespread economic damage to Georgia."

Blake R. Van Leer

President, Georgia Institute of Technology

letters

Editors: Horace Sturgis has sent me a copy of The Research Engineer for April 1954 which contains President Van Leer's excellent article on APEG. I appreciate this fine plug for APEG, and I want to congratulate President Van Leer and the faculty for the service Georgia Tech is rendering to the cause of education, all across the board.

J. Harold Saxon
Secretary, Georgia Education Association, Atlanta

APEG is the abbreviation for an Adequate Program of Education for Georgia, a statewide better schools movement recently launched by the GEA.

Editors: In reviewing various papers which I have accumulated pertaining to time study. I have discovered your article [Jones, Dale: "The Georgia Tech Auto-Graphic Time Study Machine," RE, July]. Members of the Detroit Time Study Engineering Society have shown a great deal of interest in this tool and have indicated a desire to have a program presented by Dr. Jones on this subject. . . .

James P. Mahoney
Detroit

The author met with the Time Study Engineering Society, an affiliate of the Engineering Society of Detroit, in December.

Editors: I have noticed your article [Prince, M. David: "Linear Sine Paper and Its Engineering Applications," RE, April]. I believe that your article would be of much interest to our readers, therefore, I would like to publish the enclosed abstract in our 1956 annual Handbook of Product Design. May we have your permission and that of the Engineering Experiment Station? . . .

Joseph Kerr
Assistant to the Editor
Product Engineering
New York

Permission was, of course, given gladly.

Editors: The time study machine described in your July issue looks most interesting. Would it be possible to obtain glossy, unretouched, original prints of the cover picture and also the one on page 3?

Anne Gardner
Industrial Editor
Dun's Review and Modern Industry, New York

Photographs appearing in, and original with, THE RESEARCH ENGINEER, are almost always available to other publications, on request.

Editors: Congratulations on the new look of The Research Engineer. This represents a step forward and is in keeping with the creative attitude we all hope for on the campus.

Sam T. Hurst
Associate Professor of Architecture, Georgia Tech

Scientists, engineers and business executives among our readers also have expressed approval of recent design changes in the publication.

publications

Rhodes, J. Elmer, Jr., "Note Concerning Radiation Pressure Against Perfect Reflectors." Reprinted from *American Journal of Physics*, Vol. 22, No. 2, pp. 96-97, February 1954. Reprint 81. (Supplement to Reprint 79.) Twenty-five cents.

This short contribution amplifies the earlier paper by reporting similar developments by two other authors, information which has just been turned up.

Rhodes, J. Elmer, Jr., "Thermal Energy in Almost-Normal Modes." Reprinted from *The Physical Review*, Vol. 93, No. 1, pp. 1-3, January 1, 1954. Reprint 82. Twenty-five cents.

A mode of motion that consists of a standing wave is usually assigned the thermal energy of a Planck oscillator in thermal equilibrium at the temperature of the medium carrying the standing wave. For a real standing wave which will be damped in time if it is excited beyond the thermal level, the energy of a Planck oscillator E_{PO} is not necessarily the correct energy to assign this mode at thermal equilibrium.

Ingols, Robert S., Hugh W. Hodgden, and Harold E. Miller, "Canning Plant Waste Problem Solved by Simplified Procedures." Reprinted from *Water and Sewage Works*, Vol. 101, No. 5, May 1954. Reprint 83. Twenty-five cents.

This study demonstrates that nitrates can be used to eliminate odor and to reduce biological oxygen demand (B.O.D.) in a flowing stream, thus allowing dissolved oxygen to develop more rapidly downstream. It is realized that nitrates cannot prevent oxygen depletion — indeed, cannot function without oxygen depletion — but they can serve to produce better downstream conditions while alleviating some of the objectionable features of a short-period, high-pollution load typical of canning plants.

Wrigley, William B., "Impedance Characteristics of Harmonic Antennas." Reprinted from *QST*, XXXVIII, No. 2, pp. 10-14, 100, February 1954. Reprint 84. Twenty-five cents.

The author presents a number of case studies, from which he concludes that flat-line multiband operation may be possible, but it certainly is not very practical.

Belser, Richard B., "A Technique of Soldering to Thin Metal Films." Reprinted from *The Review of Scientific Instruments*, Vol. 25, No. 2, pp. 180-183, February 1954. Reprint 85. Twenty-five cents.

The author has found that by using the metal indium and certain of its alloys as a solder, without a flux, he can readily obtain adherence to thin metal films without destruction of the films.

Walton, J. D., Jr., "Study of Strains Between Enamel and Iron as Related to Physical Properties of Each." Reprinted from *The Journal of The American Ceramic Society*," Vol. 37, No. 3, pp. 153-160, March 1954. Reprint 86. Twenty-five cents.

Engineering Experiment Station studies have developed a method whereby the stresses responsible for the strains obtained from the split-ring test may be calculated.

To order any of these reprints, or to get a complete list of Georgia Tech Engineering Experiment Station technical publications, write Publications Services, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia.

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DR. WARD

Dr. Henderson C. Ward has been appointed Associate Professor of Chemical Engineering and Research Associate. He holds three degrees from Georgia Tech, the B.S. in Ch.E., 1939; the M.S. in applied mathematics, 1952; and the Ph.D. in chemical engineering, 1953. He has worked in the atomic energy field at Oak Ridge, and he joined the staff here from a position in the chemical industry.

Assistant Research Engineer H. R. Hudson *has joined the staff of the Station and the Daniel Guggenheim School of Aeronautics in charge of the wind tunnel. Mr. Hudson holds the B.S. in M.E. from Georgia Tech, 1934, and has taken graduate studies here. He has taught high school physics and astronomy and had four years' experience during World War II in the maintenance of naval aircraft. His hobbies are astronomy and model airplanes.*


DR. McDANIEL

Research Physicist Earl W. McDaniel recently joined the staff of the Physics Division to take part in an expanded program in nuclear physics. For the past four years he has been at the University of Michigan, where he has had wide experience in the operation of the "atomic clock," a device which enables scientists to determine the ages of certain types of objects and materials up to 5 billion years old by measuring their radioactivity. Techniques utilizing tritium permit the dating of specimens from about one to 50 years old; others using uranium and thorium permit the dating of mineral specimens from 1 million to several billion years old. In between, the best developed of the new dating methods utilizes radiocarbon to fix the dates of archeological specimens from about 150 to about 40,000 years in the past. The Station is expected to become the first research institution in the Southeast to establish a radiological dating laboratory.